PROCEEDINGS

53. IWK

Internationales Wissenschaftliches Kolloquium

International Scientific Colloquium

Faculty of
Mechanical Engineering

PROSPECTS IN MECHANICAL ENGINEERING

8 - 12 September 2008

www.tu-ilmenau.de

TECHNISCHE UNIVERSITÄT
ILMENAU

Home / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=17534

Published by
Impressum

Publisher Herausgeber	Der Rektor der Technischen Universität Ilmenau Univ.-Prof. Dr. rer. nat. habil. Dr. h. c. Prof. h. c. Peter Scharff
Editor Redaktion	Referat Marketing und Studentische Angelegenheiten Andrea Schneider
	Fakultät für Maschinenbau Univ.-Prof. Dr.-Ing. habil. Peter Kurz, Univ.-Prof. Dr.-Ing. habil. Rainer Grünwald, Univ.-Prof. Dr.-Ing. habil. Prof. h. c. Dr. h. c. mult. Gerd Jäger, Dr.-Ing Beate Schlütter, Dipl.-Ing. Silke Stauche
Editorial Deadline Redaktionsschluss	17. August 2008
Publishing House Verlag	Verlag ISLE, Betriebsstätte des ISLE e.V. Werner-von-Siemens-Str. 16, 98693 Ilmenau

CD-ROM-Version:

Implementation Realisierung	Technische Universität Ilmenau Christian Weigel, Helge Drumm
Production Herstellung	CDA Datenträger Albrechts GmbH, 98529 Suhl/Albrechts

ISBN: 978-3-938843-40-6 (CD-ROM-Version)

Online-Version:

Implementation Realisierung	Universitätsbibliothek Ilmenau ilmedia Postfach 10 05 65 98684 Ilmenau

Home / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=17534

53rd Internationales Wissenschaftliches Kolloquium
Technische Universität Ilmenau
08 – 12 September 2008

M. Funck / P. Loosen

Estimating the Performance Gain of Selectively Assembled Optical Systems

Laser marking has evolved to a versatile production technology and a growing market for inexpensive lasers for marking applications is expected. Currently, the assembly of laser systems is largely performed manually, employing adjustable mounts for optical elements. New ways of laser assembly need to be developed in order to stay competitive on the global market, a central aspect being analysed in the Cluster of Excellence “Integrative Production technology for High-Wage countries” [1, 2].

Diode pumped solid state lasers have the potential to be assembled automatically and recently, a robot-assisted assembly of solid state lasers, omitting adjustable mounts and instead directly bonding components to a ceramic substrate has been reported [3]. Using lower quality components selective assembly can be employed to enhance a product’s flexibility in terms of fabrication technologies of components or choice of component suppliers while improving product quality [4]. Selective assembly of optical systems has been investigated in the past [5, 6].

A slab laser configuration is especially suitable for automated assembly, as it enables surface mount technologies on a planar substrate. The light of a diode laser bar is homogenized and directed onto a laser crystal with a set of micro optical elements (Figure 2). A centered and normal incidence on the laser crystal is critical, as an asymmetric thermal lens would degrade the beam quality. All optical components will be soldered to a ceramic substrate, prohibiting vertical adjustments. Selective assembly is expected to reduce the centration error even for a small batch production.

The most important parameters are identified with the help of sensitivity and accompanying Monte Carlo analyses of a simplified ray-tracing model. Decentration of both lenses, laser diode bar and laser crystal and a tilt of the second lens impact the quality criterion an order of a magnitude more than any other parameter. The quality criterion is a merit function combining decentration and angle of incidence. Multiple sets of components with randomly varying parameters are simulated for every element and used to predict the performance of several assembled systems. Every component is used only once and no components are left over. Selective assembly allows selecting the best systems out of all possible permutations, which can be computed for a small number of systems. Figure 1 depicts cumulated probability curves for the worst out of six systems with matched and unmatched components. Thus, for a given probability, all six systems meet or exceed the according value of the merit function. For a limiting merit function of 0.03 selective assembly can raise the yield from about 25 to 90%.

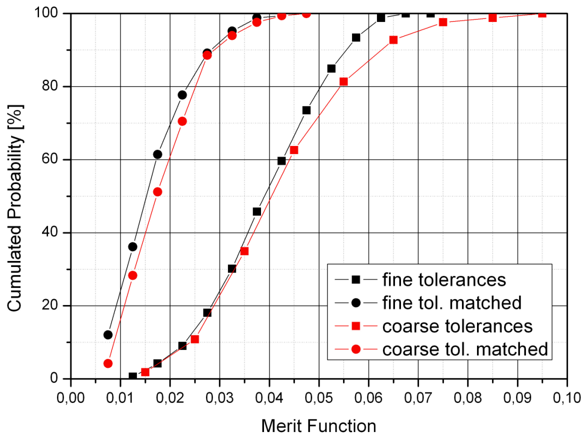

Figure 1: Selective and random assembly of 6 systems

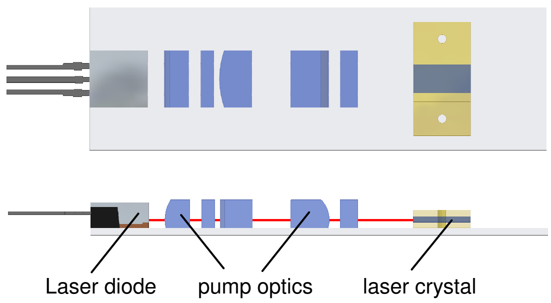

Figure 2: Laser system

Even for a selection of only six systems, a significant improvement has been demonstrated. Whereas coarse tolerances of laser crystal decentration (twice as wide) directly impact random assembly, selective assembly can tolerate larger tolerances without loosing much of the gained improvement.

References:

[1] Orilski, S. and Schuh, G.; Roadmapping for Competitiveness of High Wage Countries; Proceedings of the XVIII ISPIM Conference: on Innovation for Growth - the Challenges for East and West; 2007

[2] Schuh, G., Klocke, F., Brecher, C., and Schmitt, R.; Excellence in Production; Apprimus-Verlag; Aachen; 2007

[3] Woods, S. and Pfanz, T.; DPSS lasers rival fiber lasers for marking applications; Laser Focus World 44; 2008

[4] Warnecke, H.-J.; Die Montage im flexiblen Produktionsbetrieb; Springer; 1996

[5] Orlova, A. A., Linkov, A. E., and Zocher, K.-P.; Adaptive und Selektive Montage in der Revolvermikroskopfertigung; 50.Internationales Wissenschaftliches Kolloquium 2005

[6] Zocher, K.-P. and Pankratz, R.; Entwicklung und Fertigung von Mikroobjektiven unter dem Aspekt der Adaptiven und Selektiven Montage; 50.Internationales Wissenschaftliches Kolloquium; 2005

Authors:

Dipl.-Ing. Max Christian Funck
Prof. Dr. rer. nat. Peter Loosen
Lehrstuhl für Technologie Optischer Systeme RWTH Aachen University, Steinbachstr. 15
52074 Aachen
Phone: +49 0241 8906351
Fax: +49 0241 8906121
E-mail: max.funck@ilt.fraunhofer.de